

Anatomy of the Repo Rate Spikes in September 2019

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Key Findings

1

A confluence of factors caused the spike.

If these individual events had occurred independently of each other, they would not have been nearly as disruptive.

2

Lack of price transparency exacerbates the effects of imbalances.

Repo market participants cannot observe prices across all market segments, which can lead to imbalances and price spikes.

3

The Federal Reserve's daily repo operations alleviated the spike.

In intraday transactions data, we find evidence that the facility accomplished its goal of lowering interdealer repo rates.

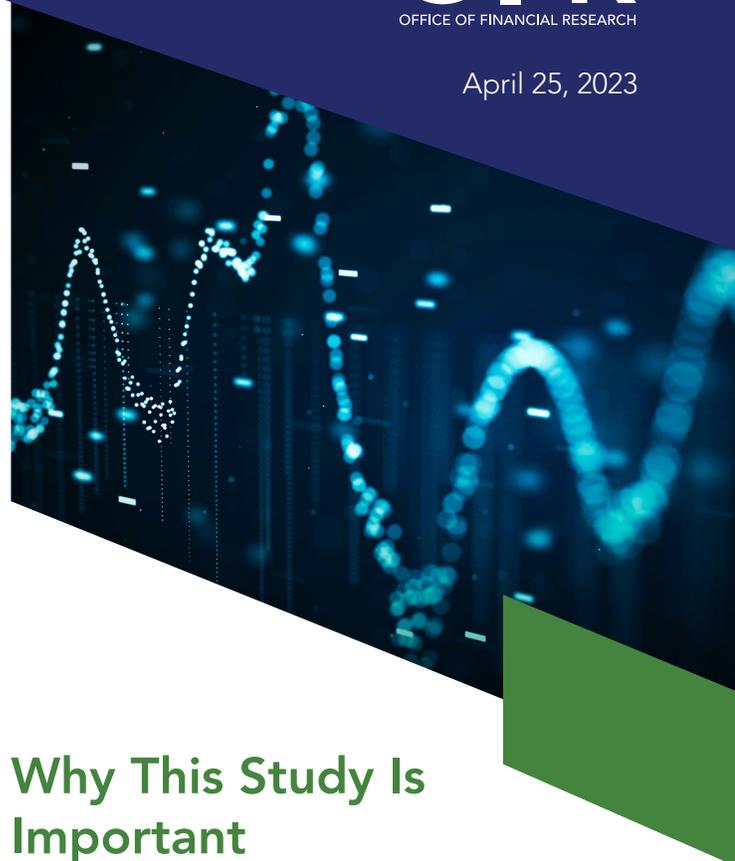
Why This Study Is Important

The repo market is the major source of short-term funding for a wide variety of financial institutions. Its efficient functioning is essential to the stability of financial markets and the setting of short-term interest rates such as SOFR. It is important to understand how the opacity of this market and the limited flexibility of participants can exacerbate interest rate moves in the market. This can help regulators and participants promote the smooth functioning of securities markets and understand movements in SOFR.

How We Did This Study

This paper uses a unique combination of intraday timing data from the repo market to examine the potential causes of the dramatic spike in repo rates in mid-September 2019.

We assembled transaction-level data on three of the four U.S. repo markets for the period from September 9 to 20. This data allowed us to examine both multiday and intraday patterns of rates and volumes, which reveal key insights into how the repo spike unfolded in real time.



Anatomy of the Repo Rate Spikes in September 2019

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Abstract

Repurchase agreement (repo) markets represent one of the largest sources of funding and risk transformation in the U.S. financial system. Despite the large volume, repo rates can be quite volatile, and in the extreme, they have exhibited intraday spikes that are 5-10 times the rate on a typical day. This paper uses a unique combination of intraday timing data from the repo market to examine the potential causes of the dramatic spike in repo rates in mid-September 2019. We conclude that the spike resulted from a confluence of factors that, when taken individually, would not have been nearly as disruptive. Our work highlights how a lack of information transmission across repo segments and internal frictions within banks most likely exacerbated the spike. These findings are instructive in the context of repo market liquidity, demonstrating how the segmented structure of the market can contribute to its fragility.

Keywords: Repurchase agreements, financial intermediation, market segmentation, short-term funding, rate spikes.

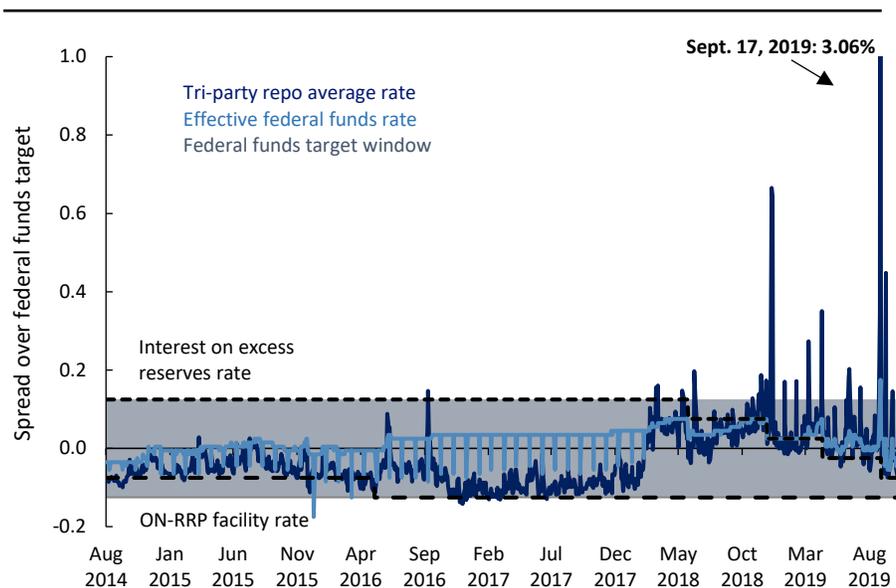
JEL classification: G14, D40, D82

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1. Introduction

Repurchase agreement (repo) markets represent one of the largest sources of funding and risk transformation in the U.S. financial system. They provide a relatively stable and flexible source of secure short-term funding for banks, securities dealers, and other large financial institutions that rely on the market to fund short-term liquidity provision and leveraged investments. Currently, the daily volume of transactions on all U.S. repo markets exceeds \$3 trillion. Despite the large volume, repo rates can be quite volatile, and in the extreme, they have exhibited intraday spikes that are 5-10 times the rate on a typical day. A notable example, and the focus of this work, occurred on September 17, 2019—when the intraday repo rate rose to more than 300 basis points above the upper end of the federal funds target range. This was 30 times larger than the same spread during the preceding week (see **Figure 1**). Although short-lived, this event and its spillover into other short-term funding markets, such as the federal funds market, prompted the Federal Reserve to step in and introduce cash to the market through a repo facility.

Figure 1. Repo Rates and Federal Funds Rates (percent)



Note: Tri-party repo average rate is the weighted average daily rate on new overnight Treasury repo transactions from BNYM repo data. All rates are spreads over the federal funds target range midpoint. Sources: FRBNY Effective Federal Funds Rate, FRB BONY Tri-Party Repo Collection, FRED, Office of Financial Research

Using a unique combination of data sources available to the OFR, we examine the potential causes of the dramatic spike in repo rates in mid-September 2019. We distinguish between immediate contributing factors, such as tax payments and Treasury issuance dates, and more fundamental factors, such as reserve levels and the segmented

character of the repo market.² A novel contribution of the paper is its detailed analysis of the intraday and interday dynamics of different repo market segments, which sheds light on the roles of different classes of intermediaries in the market. The paper's results suggest that a lack of transparency plus imperfect intermediation may have substantially contributed to the disruption, as observed in the pattern of intraday rate movements on September 16-17 in different segments of the market.

Understanding the sources of volatility in repo rates is not just important for financial institutions, but for policymakers as well. The repo market underpins SOFR, which has supplanted LIBOR as the primary reference rate for a diverse range of financial products.³ By shedding light on how segmented markets can increase the fragility of the repo market during stress times, our work informs future policy considerations for strengthening repo market functioning.

2. Structure of the Repo Market

Before proceeding, we present a brief overview of the main repo markets and how they differ in participation, clearing, transparency, type of collateral, and settlement times.⁴ Understanding these differences is key to understanding how structural features of the repo market can exacerbate price volatility.

A repo transaction involves the sale of assets together with an agreement to repurchase them on a specified future date at a prearranged price. Market participants use repos for many reasons, including financing their portfolios, using cash as collateral to borrow securities, and as a safer alternative to uninsured deposits. Central banks also use repos as important monetary policy tools.

Assets underlying a repo are used as collateral to protect cash lenders against the risk that cash borrowers will fail to return the cash. Cash lenders typically require overcollateralization, and thus, the value of the assets pledged as collateral is discounted. This discount is typically referred to as a *haircut*. Additionally, repo transactions specify the types of securities that are acceptable as collateral, as well as the associated haircuts or initial margin requirements. Although most repos are overnight transactions, they can be entered into with a range of maturities. The interest rate on these transactions is calculated based on the difference between the sale price and the repurchase price of the

² For a discussion of some of these factors in the prior literature, see Copeland, Duffie, and Yang (2020), Anbil and Senyuz (2021), Afonso et al. (2020), and Correa, Du, and Liao (2020).

³ See Facilitating the LIBOR Transition (Regulation Z), CFPB, Dec. 7, 2021 (codified at 12 C.F.R. § 1026) <https://www.federalregister.gov/documents/2021/12/08/2021-25825/facilitating-the-libor-transition-regulation-z>

⁴ For more detailed reviews about the repo market, see Copeland, Martin, and Walker (2010), Copeland, Duffie, Martin, and McLaughlin (2012), Adrian, Begalle, Copeland, and Martin (2014), Baklanova, Copeland, and McCaughrin (2015), Anbil, Anderson, and Senyuz (2021), and Kahn and Olson (2021).

assets underlying the repo, and the rate can be negotiated on either a fixed or a floating basis.

2.1 Repo Market Segments

The U.S. repo market has four distinct segments. One way of describing these segments is by distinguishing between transactions that are settled on the books of a tri-party custodian bank and transactions that are settled bilaterally. Two segments settle on the books of a tri-party custodian: (1) the noncentrally cleared tri-party repo segment, in which the Bank of New York Mellon (BONY) serves as the custodian, and (2) the centrally cleared General Collateral Finance (GCF) repo segment, which is cleared by the Fixed Income Clearing Corporation (FICC). The tri-party segment primarily consists of dealers and large banks borrowing from smaller dealers, money market funds (MMFs), and other asset managers. Tri-party is also the segment through which the Federal Reserve intervenes in the repo market. The GCF segment largely consists of transactions between large financial institutions like dealers, banks, and government-sponsored enterprises (GSEs).⁵

Bilateral transactions occur in two additional segments: (3) those cleared by FICC's Delivery-to-Payment (DVP) repo service, and (4) noncentrally cleared bilateral repos (NCCBR). DVP is a large segment between clearing members that allows dealers to trade specific securities. It also includes trades with certain other institutions, such as MMFs and hedge funds, that are not direct clearing members but are allowed to participate through sponsorship by a clearing member. These trades are known as *sponsored DVP repo*. Meanwhile, the noncentrally cleared bilateral repo market serves as an important source of leverage for hedge funds, and it is also the primary venue for repo lending by primary dealers. However, there is no data available on this market for September 2019, and thus, it is not a part of our dataset.

Figures 2 and 3 display these four distinct segments of the market and the flow of funds between the principal participants.

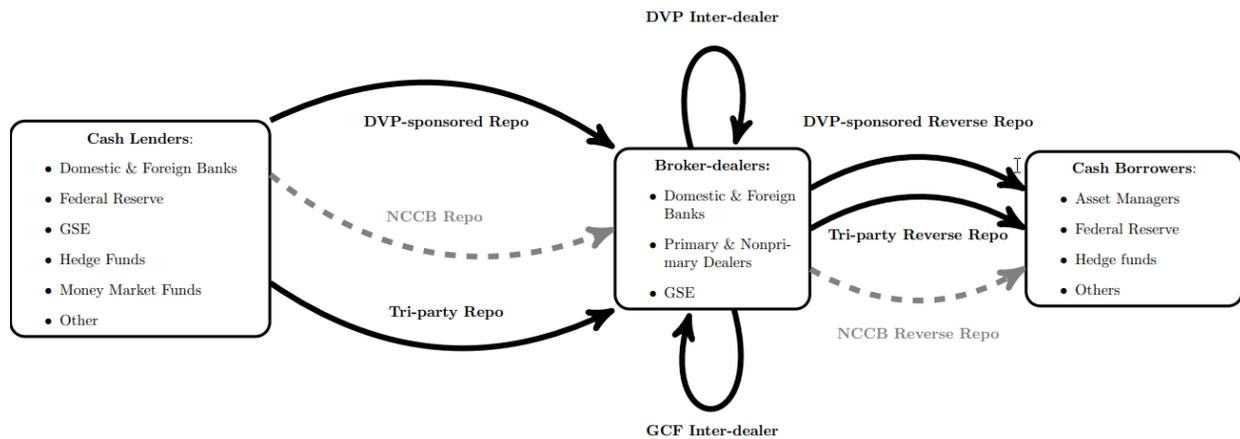
⁵ There is also a Sponsored General Collateral service market that offers transaction types that are similar to those offered by the existing FICC GCF repo service. However, the Sponsored General Collateral service allows entities who are not direct clearing members of FICC to participate in these transactions. Because this market only began trading in September 2021, following its approval by the Securities and Exchange Commission (SEC), it is not part of our discussion.

Figure 2. Repo Market Segments and Their Principal Participants

		Central Clearing (FICC)		Participants	Repo Market		
		Yes	No		DVP	GCF	Tri-party
Custodian Bank	Yes	GCF	Tri-party	Asset Managers	✓		✓
	No	DVP	Bilateral	Domestic Banks	✓	✓	✓
				Foreign Banks	✓	✓	✓
				Primary Dealers	✓	✓	✓
				Nonprimary Domestic Dealers	✓	✓	✓
				Nonprimary Foreign Dealers	✓	✓	✓
				Federal Reserve			✓
				GSE	✓	✓	✓
				Hedge Funds	✓		
				MMFs	✓		✓
				Other	✓		✓

Source: Office of Financial Research

Figure 3. Flows to and from the Repo Market



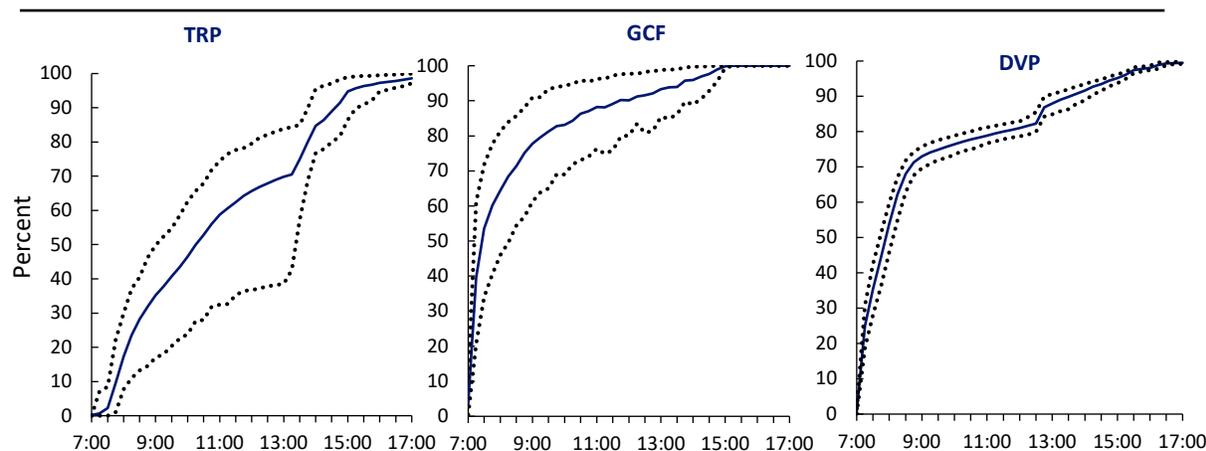
Source: Office of Financial Research

2.2 Daily Repo Clearing Cycle

The majority of funding provided via repos in the U.S. financial system is overnight and therefore can be renegotiated on a daily basis. **Figure 4** presents the average intraday clearing cycle for GCF, DVP, and tri-party. This figure highlights the fact that most of the activity in each repo market segment occurs during only a few hours in the morning. Within each market segment, hourly rates typically vary by just a few basis points over the course of the day. Trades in cleared DVP and GCF generally occur slightly earlier

than in tri-party, in part because of settlement-timing differences between these markets.⁶ Moreover, the concentration of volumes at the beginning of the day has been explained by market participants as a response to overdraft fees assessed by clearing banks at 8:30 a.m.

Figure 4. Daily Clearing Cycle for Tri-party (TRP), GCF, and DVP



Note: This figure shows cumulative distribution functions of volume transacted at 15-minute intervals over 2021.

Sources: OFR Cleared Repo Collection, FRB BONY Tri-Party Repo Collection, Office of Financial Research

3. Potential Causes of Rate Spikes

Our analysis begins with a review of a variety of factors that may have contributed to the abrupt spike in repo rates in September 2019. Some factors are transitory, while others result from long-term trends that brought about an overall tightening in money markets. We first review two events that occurred on September 16—quarterly tax payments and the settlement of Treasury debt issuances—that have been widely regarded as direct triggers of a liquidity squeeze in repo markets.

3.1. Quarterly Tax Payments and Treasury Settlement

In the week leading up to the rate spike, the Treasury Department issued \$78 billion⁷ of government debt that was due to settle on September 16. While the settlement was neither unexpected nor exceptionally large, it occurred against a backdrop of enormous long-term growth in the total amount of Treasury securities outstanding. From 2016 to 2019, total public debt outstanding increased from roughly \$13.5 trillion to nearly \$17 trillion.

⁶ See Chow et al. (2021), Copeland, Duffie, and Yang (2021), and Paddrik et al. (2021). Additionally, these figures are calculated over 2021, so the tri-party timing figure likely reflects the presence of the Federal Reserve’s ON RRP facility, which operates later in the day than many private repo transactions.

⁷ Note that the net volume was \$19 billion, given that \$24 billion of nominal coupons and \$35 billion of CMBs matured that same morning.

Settlement of large issuances of Treasury notes and bonds places upward pressure on repo rates via two key mechanisms. First, it reduces the supply of cash available in the financial system because buyers pay for the new debt by withdrawing money from banks and money markets and placing it in the Treasury General Account (TGA) at the Federal Reserve. Second, it generates additional demand for repo to finance purchases of these Treasury securities. A significant share of repo demand comes from primary dealers, who absorb a substantial share of Treasury issuances onto their balance sheets until they can gradually sell them to their customers.

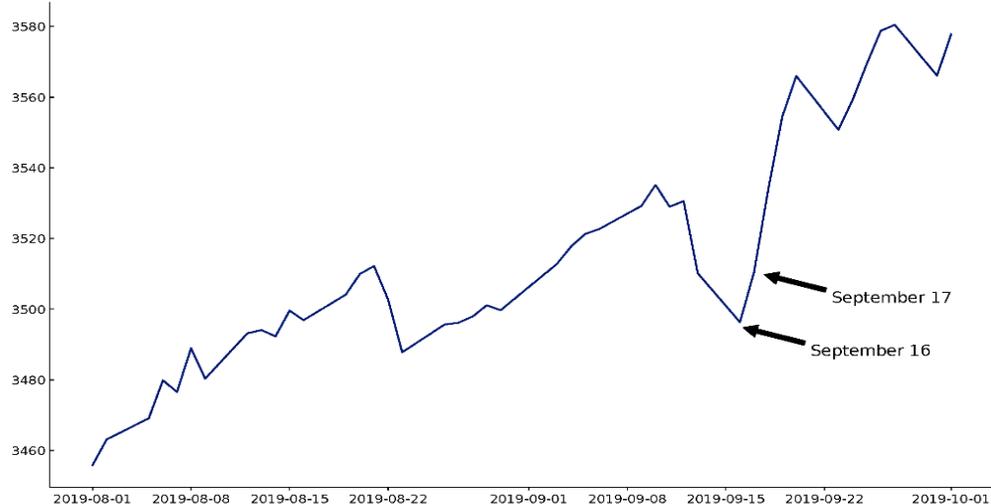
The effects of issuance may have been exacerbated by the large increase in Treasuries outstanding over the previous three years, combined with limited demand from foreign purchasers of Treasuries. Combined, these two forces contributed to a larger amount of Treasuries remaining on dealer balance sheets for longer. With net Treasury positions held by primary dealers near all-time highs in September, it is possible that the additional debt issued added to the already strained balance sheets of dealers by increasing their repo borrowing, thus further strengthening upward pressure on repo rates (Anbil, Anderson, and Senyuz (2020a)).

In addition, corporate tax payments for the third quarter of 2019 were due on the same day that Treasury settlement was due: September 16. Corporate tax payments result in a transfer of cash from MMFs, which hold balances on behalf of their corporate clients, to the TGA at the Federal Reserve. As with Treasury settlement, this led to a reduction in the supply of cash available to the repo markets on September 16.

To provide some detail on the drivers of MMF activity and their relationship to these tax payments, we assemble a daily series of MMF total assets from Crane's Money Market Fund Monitor. We then match each MMF to lenders across tri-party and DVP markets at the fund family level. Matching at the family level is key because market participants report that MMFs make joint decisions within a family on their allocations of cash to repo. This mapping allows us to establish a daily panel of MMF family assets matched with repo lending in both DVP and tri-party.

In **Figure 5**, we show a daily series of MMF total assets. The effect of the tax deadline was a decrease in MMF total assets by about \$35 billion on September 16 from the week prior. This is in line with decreases observed on previous tax dates. As we will show in Section 4, this reduction in MMF assets corresponds almost one-to-one with the decrease in MMFs' repo lending.

Figure 5. Money Market Fund Assets (\$ billions)



Note: This figure tracks the total for all MMFs appearing throughout the subsample.
Sources: Crane’s Money Market Fund Wisdom, Office of Financial Research

3.2. Other Proximate Causes

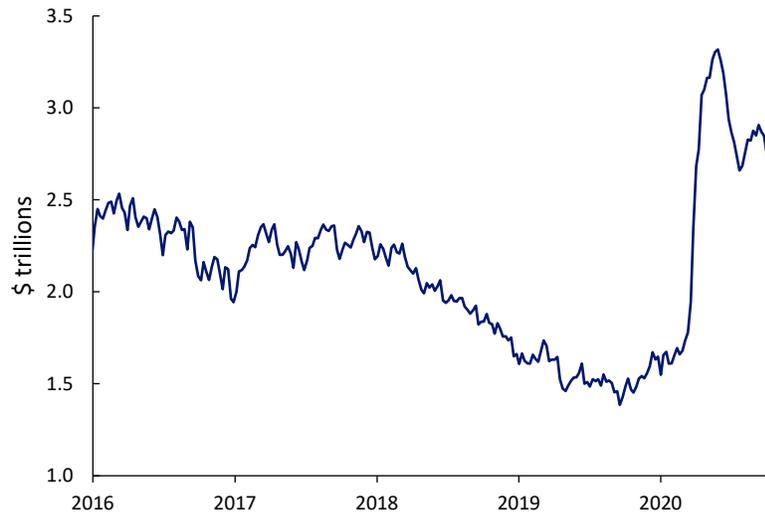
Some market commentators have suggested that sponsored repo borrowing by hedge funds, which rely on repo to fund arbitrage basis trades using highly leveraged positions, may have been a contributing factor.⁸ As we shall see in Section 4, however, increased borrowing by hedge funds through sponsored DVP repo was quite minor compared to other changes in supply and demand in mid-September 2019. Other observers have suggested that an unanticipated oil shock in Saudi Arabia led to a surge in margin calls at commodity exchanges, which in turn reduced the amount of cash available for repo lending (Kaminska (2019) and Domm (2019)). Given data limitations, however, we have not been able to verify either of these potential explanations.

3.3 Reserve Balances in the Lead-up to September

Several papers have noted the additional effects of low levels of reserves and high levels of outstanding Treasuries in driving the September 2019 repo spike, including Copeland, Duffie, and Yang (2020) and D’Avernas and Vandeweyer (2021). In October 2014, reserves stood at a high of roughly \$2.8 trillion, but from 2017 to 2019, the Federal Reserve began gradually reducing the size of its balance sheet by not reinvesting a part of its maturing securities. Consequently, aggregate reserves declined to a multiyear low of less than \$1.4 trillion by mid-September 2019 (see **Figure 6**).

⁸ See in particular Avalos, Ehlers, and Eren (2019) and Smith (2019). For more on the basis trade, see Barth and Kahn (2021).

Figure 6. Aggregate Bank Reserves: 2016-2020 (\$ trillions)



Sources: FRED, Office of Financial Research

While low levels of reserves and high Treasury issuances may have indeed played a role in the September spike, it is worth noting that there were several days in the tightening cycle when reserves were at similarly low levels but no spike occurred. This suggests that while the supply of reserves by itself may not have been sufficient to lead to a repo spike, we also have to consider the net demand for cash from dealers in the repo market.

In **Figure 7**, we show days when repo rates spiked, along with a measure of net funding demand on repo markets over the four-year period from 2016 to 2019. Our net funding demand measure is designed to capture two important features of the demand for funding by dealers: (1) new Treasury issuance increases dealer demand for repo borrowing to fund the new issuance, and (2) net inflows to MMFs increase the amount of cash available to dealers. The latter is due to the fact that repos are the most liquid assets available for MMFs to invest new cash into and thus are the primary absorber of changes in MMFs' asset holdings. We therefore construct our measure of net funding demand as the sum of net bond and note issuances, minus the change in MMF assets over a 14-day moving average.

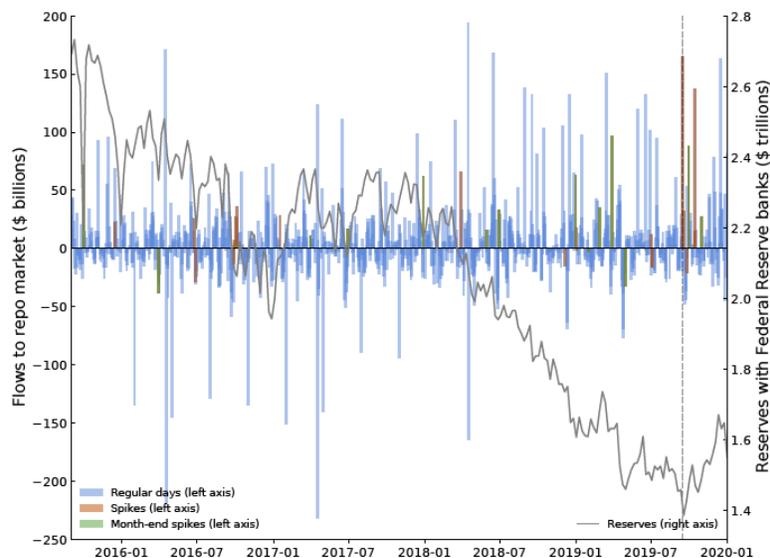
In other words, a positive sign on our net funding demand measure suggests *funding pressure*, in the sense that there is net demand for funding above levels that can be easily met by funds from MMF inflows. On the other hand, a negative sign suggests there is sufficient funding from MMF inflows to cover demand for funding new issuances. In the case of funding pressure, since MMFs cannot provide enough funding from inflows to cover repo financing demand from dealers to fund the new issuance, dealers may need

to source funding from banks. This creates funding pressure because such lending to dealers requires banks to reduce their reserve balances. Due to the regulatory pressures described above, or potentially as a result of more mundane institutional inflexibility, these other potential sources of cash can be relatively slow to respond to repo market price signals.

Note that the size and frequency of episodes of funding pressure increased noticeably beginning in mid-2018. This corresponds to the period when the total volume of Treasury issuances increased, and it occurred while aggregate reserves were decreasing. While funding pressure on September 16 and 17 was among the highest during the period, there were other dates when similarly high pressure occurred but rates did not spike. These results suggest that although spikes and funding pressure are positively correlated, neither pressure nor levels of reserves are by themselves sufficient to explain funding spikes.

In fact, September 17 provides an example of this imperfect relationship among funding pressure, reserves, and rate spikes. While September 16 was both a Treasury settlement day and a day of large outflows from MMFs associated with the tax deadline, these factors were not present on September 17. Yet, even though there was arguably less funding pressure on September 17, rates were much higher than on the previous day. This suggests that other factors beyond reserve supply and funding demand may have been important in triggering the extreme increase in rates.

Figure 7. Daily Net Funding Demands in the Repo Market: 2016-2020.



Note: The dashed line indicates September 17, 2019.

Sources: TreasuryDirect, Crane’s Money Market Fund Wisdom, Federal Reserve Statistical Release H.4.1: “Factors Affecting Reserve Balances,” Office of Financial Research

3.3. *Other Factors*

Beyond these explanations, internal frictions may have played a role in increasing banks' demand for reserves and reducing their flexibility in responding to price signals in repo. While the aggregate supply of reserves was still large relative to the period preceding the 2008 financial crisis, the level of reserves required by banks may have increased due to the suite of regulatory and supervisory programs put in place post-2008. In particular, the Liquidity Coverage Ratio (LCR) and Regulation YY's requirements for Resolution Liquidity Adequacy and Positioning (RLAP) may have increased banks' demand for reserves. Broadly, the LCR requires banks to prefund a sufficient amount of High-Quality Liquid Assets (HQLA) (i.e., assets such as Treasuries or reserves that can be converted into cash) to meet its projected net cash outflow over a 30-day stress period. Although reserves and Treasuries are both HQLA of equivalent standing, Andolfatto and Ihrig (2019) report that banks occasionally feel pressured to hold reserves rather than Treasuries to satisfy their HQLA requirements. More importantly, RLAP imposes additional restrictions by requiring each individual subsidiary to hold enough HQLA to meet expected intraday outflows without relying on transfers from affiliates. This reduces the flexibility of banks in sourcing funds internally, making them less likely to increase repo lending by sourcing cash from other parts of the firm.

More generally, the spillovers from the September 2019 repo episode to the FX swaps market noted by Tran (2020) and others are likely indicative of such internal frictions. Some spillover between these markets would naturally result from foreign banks choosing to source U.S. dollars in FX swaps instead of repo. However, the FX swaps market is heavily intermediated by the same GSIBs that are active in repo, and lending in FX swaps increased relative to repo despite a smaller increase in rates (Correa, Du, and Liao 2020). These latter facts provide suggestive evidence that frictions in banks' ability to internally reallocate capital led to these adjustments being made instead on an external margin.

In addition, the events of the 16th occurred in a brief window between two GSE "float periods," which may have reduced the availability of cash in repo markets. Prior to the introduction of the uniform MBS, Freddie Mac and Fannie Mae would pay principal and interest on MBS securities on the 15th and 25th of the month, respectively (Anderson and Huther 2016). During periods of approximately 5 days leading up to these payment dates, the GSEs hold cash reserves used for payments at the Federal Reserve, or they invest in repos. September 16 would have been the Freddie Mac payment date, and it occurred

before Fannie Mae would have begun building up cash reserves, leading to a likely net outflow of cash from repo markets relative to the prior week.

Finally, the U.S. repo market is highly segmented. In the tri-party segment, deals are negotiated bilaterally, and thus, trading dynamics depend on strong relationships between dealers and MMFs. In contrast, the FICC-cleared DVP segment is brokered, so the identities of borrowers and lenders remain anonymous. Moreover, only a few primary dealers and banks can access both segments, while smaller dealers are confined to only the FICC-cleared segment. As a result of this segmentation, Anbil, Anderson, and Senyuz (2020b) observed that on September 16-17, smaller dealers faced higher funding costs—almost 1 percentage point higher, relative to other FICC participants—given their lack of access to the tri-party segment. Higher repo rates in the FICC-cleared segment then transmitted to the tri-party segment because MMFs were able to extract higher rates from dealers, who were willing to pass on profits to maintain these strong trading relationships.⁹ The effects of segmentation may have been exacerbated by a great deal of uncertainty among lenders about the reason for the sudden spike in rates, which discouraged them from stepping in promptly (Afonso et al. (2020)).

In this paper, we highlight the importance of lack of transparency in driving high repo rates on September 17. We show that because of the segmented nature of the repo market, and because customers may have limited visibility into repo markets on a high-frequency basis, rates for large cash providers such as MMFs lagged behind interdealer rates when cash became scarce on September 16. Then, we show that on September 17, when cash became less scarce following the Federal Reserve’s intervention, rates demanded by MMFs remained high. This suggests that limited transparency or stickiness in MMFs’ investment decisions played a role in the extreme rate highs on September 17, since the scarcity of funds in the interdealer segment of the market was not reflected in the returns MMFs could receive for introducing more cash into the market.

4. Interday and Intraday Analysis of September 16-18, 2019

In this section, we take a closer look at the intraday pattern of rates and the changes in supply and demand for funding on September 16-18.

4.1 Lending and Borrowing Behavior

First, we examine the lending and borrowing behavior of different categories of firms on September 16-18, relative to an average day during the prior week, when conditions were

⁹ For a broader discussion of repo market trading dynamics, see Han and Nikolaou (2016) and Anbil and Senyuz (2020).

fairly quiet. Figures 8a and 8b show the changes in aggregate lending and borrowing, respectively, over three repo markets (tri-party + DVP + GCF) for eight different categories of firms. Figure 8c provides a unified picture by showing the net change in lending minus borrowing for each class of participants.

Figure 8a. Change in Lending (\$ billions) in DVP, Tri-party, and GCF, Compared to an Average Day During the Prior Week

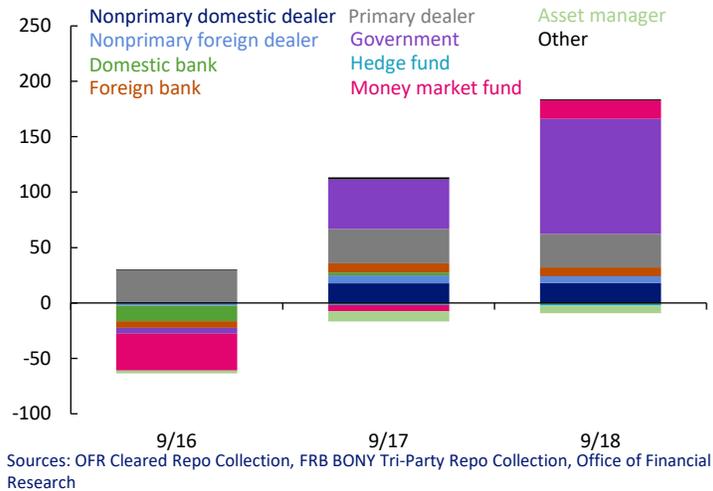


Figure 8b. Change in Borrowing (\$ billions) in DVP, Tri-party, and GCF, Compared to an Average Day During the Prior Week

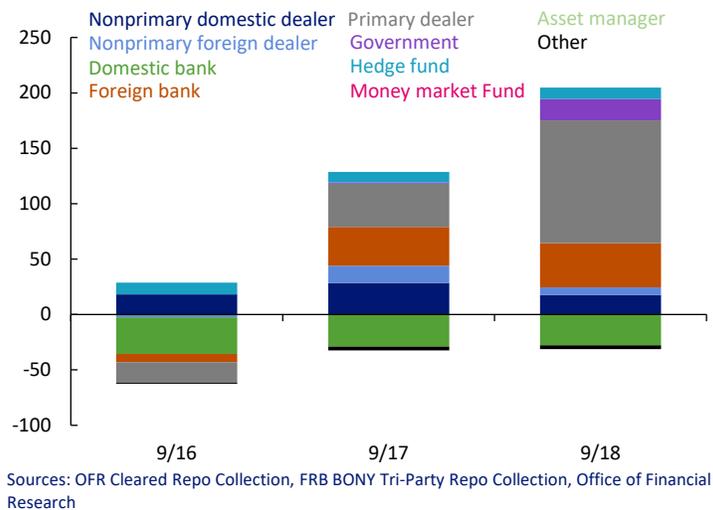
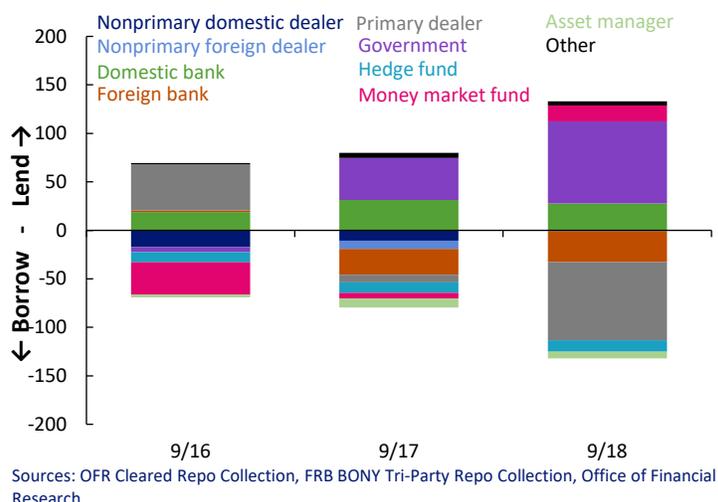


Figure 8c. Change in Lending Net of Borrowing (\$ billions) in DVP, Tri-party, and GCF, Compared to an Average Day During the Prior Week



In aggregate, the total change in transaction volume on September 16 was not particularly large compared to day-to-day changes over the subsequent period of December 2019-July 2022. Total volume over all three markets declined by 1.7%, compared with the volume on the previous trading day (September 13). Although this is much larger than the change on an average day, which is about 0.11%, the standard deviation of day-to-day changes is considerable (2.47%). Hence, the increase on September 16 was not exceptionally large, relative to the prior period. Figure 8c shows that the largest decrease in lending behavior was due to MMFs pulling back by about \$35 billion.

On September 17-18, the total volume of repo lending increased by \$75-\$125 billion compared to the prior week and by \$230 billion compared to the prior day. This exceptionally large increase was due in large part to repo lending by the Federal Reserve to primary dealers and foreign banks through the tri-party market. On net, hedge funds increased their sponsored repo borrowing by about \$8 billion, but this amount is quite small compared to the overall changes in lending and borrowing. This suggests a limited role for hedge funds' sponsored activity in the repo spike.

Money market funds represented the largest decrease in net lending on September 16. Notably, the reduction in MMF lending corresponds very nearly to the \$35 billion decrease in their assets over the prior week, as we noted in Section 3.1. In **Table 1**, we estimate a regression of MMF family lending on September 16 in different repo segments on the seven-day change in total assets for the fund family. The results show that a \$1 billion decrease in a fund family's assets corresponded to a \$0.993 billion decrease in their

total repo lending activities across both DVP and tri-party. In other words, the total reduction in MMF assets corresponds almost one-to-one with the decrease in MMF lending into repo.¹⁰ **Figure 9** plots the coefficient from column (1) along with a bin scatter of changes in MMF net assets (x-axis) and their average change in repo (y-axis). Although we do not show it here, the majority of the decrease was in DVP, which is consistent with DVP serving as a vehicle for MMFs investing excess cash. As noted by Afonso et al. (2020), this may have increased the intermediation costs for dealers who rely on funding from MMFs through sponsored repo, since netting benefits would have decreased.

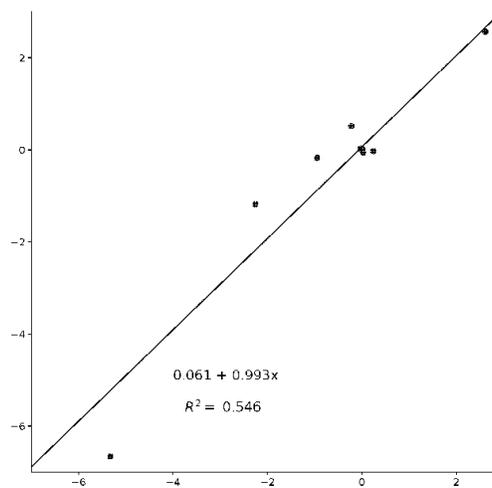
Table 1. Estimated Relationship Between Change in MMF Repo Lending as a Function of the Change in MMF Assets Relative to the Prior Week

Dependent Variable: Change in MMF Repo Lending	
DVP+Tri-party Repo	
Change in MMF Assets	0.993 (7.68)
R^2	0.546

Note: The units of the explanatory and dependent variables are billions of dollars.

Source: Crane’s Money Market Fund Wisdom, OFR Cleared Repo Collection, FRB BONY Tri-Party Repo Collection, Office of Financial Research

Figure 9. Scatterplot of Change in MMF Assets Relative to the Prior Week and Change in MMF Repo Lending



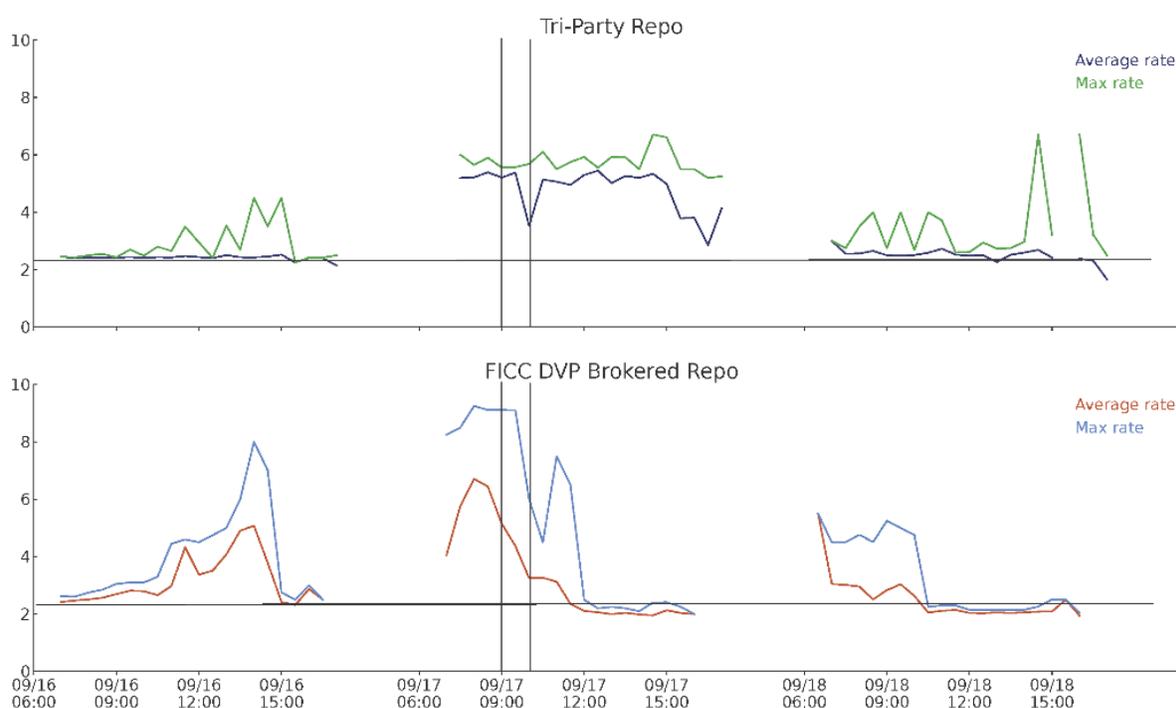
Sources: Crane’s Money Market Fund Wisdom, OFR Cleared Repo Collection, Office of Financial Research

¹⁰ In contrast, Afonso et al. (2020) estimate that over the period 2016-2019, for every dollar change in assets held by MMFs, the repo investment of MMFs changed by 0.69. Our estimates apply to behavior on the specific date of September 16, 2019, not to average behavior over the prior period.

4.2 Intraday Pattern of Rates

Next, we take a closer look at the trajectory of rates in two segments of the market: (1) the tri-party market, which is a noncentrally cleared market mostly composed of banks and MMFs lending to dealers, and (2) the DVP market, which is an interdealer-brokered market. As shown in **Figure 10**, starting around noon on September 16, maximum rates spiked to around 4% in tri-party and 8% in DVP. Average rates remained fairly steady at about 2% in tri-party, suggesting that only a limited number of firms were impacted by higher rates. Volume was relatively low because 70%-80% of the day's trades had already been negotiated by the time these spikes erupted.

Figure 10. Intraday Average and Maximum Repo Rates for Tri-party + DVP brokered: September 16-18, 2019



Note: Rates are volume-weighted averages.

Sources: OFR Cleared Repo Collection, BONY, FRBNY, Office of Financial Research

On the morning of September 17, the tri-party average rate rose to 6% and remained high for much of the traded volume that day. The two vertical lines in **Figure 10** indicate the times at which the Federal Reserve announced its intention to provide additional liquidity (9:00 a.m.) and the implementation of the liquidity injection (9:30 a.m.). Following the Federal Reserve's intervention, rates declined substantially in the DVP-brokered market but remained elevated in tri-party. By the start of trading on September

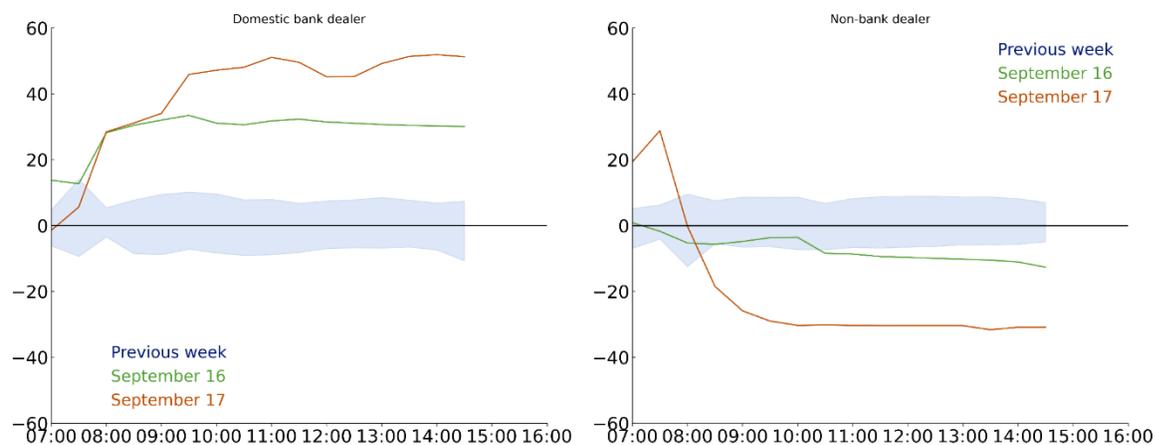
18, average rates had fallen to around 2%, but the market remained very skittish, as shown by several spikes in both the tri-party and DVP segments of the market.

The intraday pattern of rates highlights two important points. First, rates did not increase until the afternoon of September 16 and began increasing in the interdealer market. This highlights a general unawareness on the part of dealers about the potential scarcity of funds available in the market, since otherwise, dealers would have had an incentive to borrow earlier in the morning and lend excess funds. Second, there was substantial heterogeneity in the response of rates across different segments of the repo market. The dispersion of rates in the DVP and tri-party segments on the 16th suggests that although a few market participants started to learn that cash supplies were scarce, others did not realize it or were unable to lend in response to increased tightness.

5. Intraday Lending and Borrowing by Dealers

Reserves enable banks and bank-affiliated dealers to provide settlement liquidity to other market participants and avoid intraday stress on their own balance sheets due to these intermediation activities. Although we cannot directly test whether banks may have reached their minimum comfortable level of reserves (referred to here as *reserve limits*, though these do not reflect hard regulatory constraints) during the September stress, the intraday data does provide some suggestive evidence that reserve constraints on banks and bank-affiliated dealers may have played a contributing role in the repo spike. **Figures 11a** and **11b** show cumulative net lending in DVP on September 16 and 17, relative to lending on an average day during the prior week, for two categories of dealers: domestic bank-affiliated and non-bank-affiliated dealers.

Figures 11a & 11b. Cumulative Net Lending on September 16 & 17, Relative to an Average Day in the Prior Week: Dealers Affiliated with Domestic Banks and Non-bank Dealers



Note: All series are cumulative net lending in DVP at a given time, less the mean cumulative net lending at that time for the week of September 9.

Sources: OFR Cleared Repo Collection, Office of Financial Research

On the morning of the 16th, domestic bank-affiliated dealers increased net lending. But by 9:00 a.m., they had ceased to lend more, and net lending stayed flat even as rates began to rise around noon, which should have provided an additional incentive to lend. On the other hand, non-bank dealers (who are not required to hold reserves) did not lend more in response to the higher rates and instead borrowed an additional \$10 billion.

Why did bank-affiliated dealers not increase their lending after noon, despite higher rates? One possible explanation is dealers' preference for avoiding daylight overdraft fees that would have come if dealers had borrowed elsewhere to lend into the repo market. However, an alternative explanation is that these bank-affiliated dealers may have reached their minimum comfortable level of reserves. The intraday pattern of lending by dealers on the 17th suggests that this second explanation is more likely. As on the day before, on the 17th, bank-affiliated dealers began increasing lending in the morning by \$20 billion over the usual levels but stopped lending for a short period of time. It was only after the Fed provided additional liquidity at 9:30 a.m. that they increased their lending by a further \$10 billion. These results are consistent with the possibility that some key lenders had reached their minimum comfortable level of reserves by the time the Fed intervened.

For further supportive evidence of the effects of the Fed's intervention, **Table 2** examines the relationship between the amount lent by dealers from 9:30 a.m. to 10:00 a.m. in DVP and the amount borrowed from the Fed's repo facility at 9:30. We observe that for every

dollar borrowed from the Fed, a substantial share was passed through to DVP. That helps to explain the cross-sectional increase in lending on the 17th after 9:30. In other words, the Fed’s action appears to have eased reserve pressure on these bank-dealers, enabling them to lend more in DVP.

Table 2. Cross-sectional Regression of DVP Lending on September 17 on Amount Borrowed from the Fed’s Repo Facility

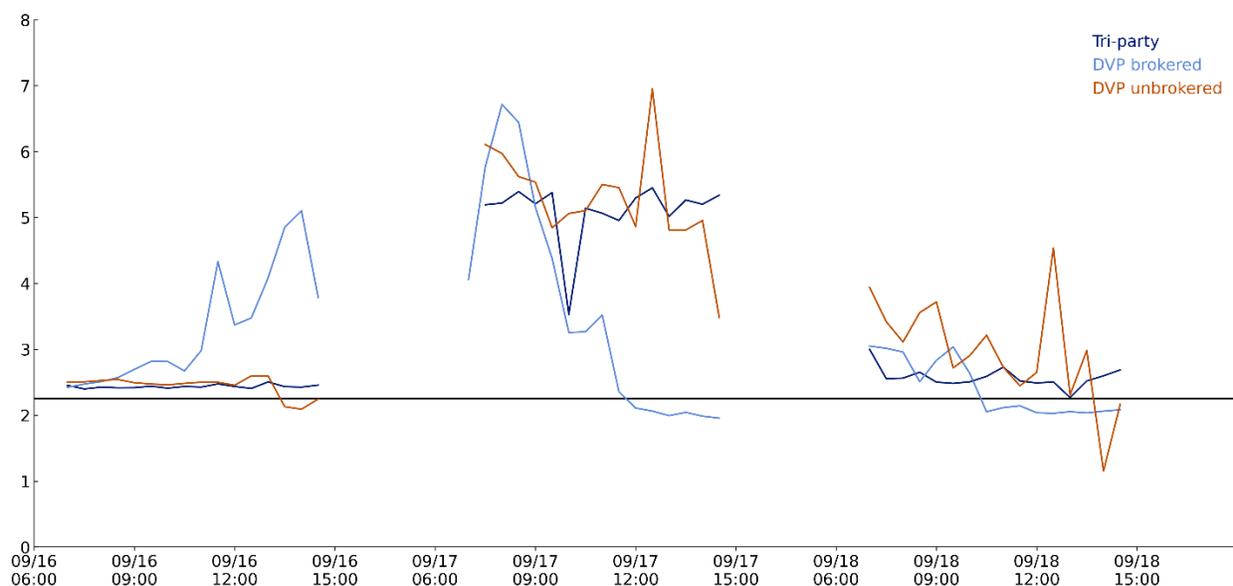
	<i>Dependent Variable: Amount Lent in DVP 9:30-10:00</i>		
	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>
Amount Borrowed from Fed	0.4649	0.1625	2.8614
R^2		0.4055	
Adjusted R^2		0.3560	
Observations		14	

Sources: OFR Cleared Repo Collection, Office of Financial Research

Nonetheless, as **Figure 10** shows, maximum rates continued to be extremely elevated in some segments of the market on September 17 and 18, after the Fed’s intervention. This suggests that the effective loosening of constraints on bank-affiliated dealers was not sufficient to eliminate spikes for several days and that there were other factors at work in addition to reserve scarcity.

6. Market Segmentation and Opacity

Figure 12. Intraday Rates on Sept. 16-18 in Tri-party and DVP



Note: Rates are volume-weighted averages.

Sources: OFR Cleared Repo Collection, FRB BONY Tri-Party Repo Collection, Office of Financial Research

Let us return to the pattern of rates that evolved over the period from September 16 to September 18 in the tri-party and DVP segments of the market. **Figure 12** shows average rates across three different segments of the repo market: (1) the tri-party market, which is a noncentrally cleared market mostly comprised of banks and MMFs lending to dealers; (2) the DVP-sponsored lending market, which is a centrally cleared market comprised of MMFs lending to dealers; and (3) the DVP interdealer brokered market.

One pattern that emerges in these figures is that nonbrokered rates such as those paid by MMFs did not track interdealer rates throughout the 16th and 17th. A scarcity of reserves should, in principle, be reflected across different segments of the repo market as interest rates increase to draw funds in from available investors of cash. But on the afternoon of the 16th, when cash was scarce in the market and rates began to rise in DVP, MMFs were still receiving low returns for investing in repo, as shown by the relatively flat tri-party rates through the day.

One explanation for this heterogeneity in response to rates is the lack of transparency between different segments of the repo market. More specifically, the interdealer brokered market takes place on transparent screens where prices are updated frequently. Meanwhile, MMFs may not have access to these screens but instead may often rely on dealers and other market participants to obtain information on the prevailing rate. As a result, it is possible that there was a period of several hours when communication between different parts of the market was somewhat opaque, leading to a temporary dispersion in rates and uncertainty about the root cause.

MMFs' lack of transparency into repo rates also helps to explain the behavior of rates on September 17. In the interdealer market, rates began to decline following the Federal Reserve's introduction of the repo facility. However, rates in tri-party and sponsored lending markets remained high throughout the day and began falling only around 3:30 p.m. Thus, not only were MMFs slow to learn about the tightness in the repo market on the 16th, but they were slow to react to the decrease in tightness on the 17th. This happened either because MMFs did not know the decrease in tightness had occurred, or because the early trade activity of MMFs came in advance of the Federal Reserve's announced intervention, which made it too late to reduce the high rates in the interdealer segment.

These disparities suggest that segmentation and lack of transparency between different parts of the market played an important role in repo rate changes on the 16th and 17th. Because most of the repo market activity takes place within the first two-hour window of the day, the speed with which information about prices can be disseminated can exacerbate the impact of sudden shifts in supply and demand. It is worth considering

whether, if clear price signals were transmitted more quickly to MMFs, the MMFs would have been able to lend more into repo and potentially decrease the impact of reserve scarcity. More generally, providing greater transparency into the repo market is also crucial to improving price discovery and liquidity and preventing future repo spikes.

7. Conclusion

This paper is the first to bring together intraday timing data on the tri-party and cleared segments of the repo market for the purpose of studying the causes of the unusually large interest rate spike in repo markets in September 2019. We conclude that, in large part, the spike resulted from a confluence of factors—large Treasury issuances, corporate tax deadlines, and an overall lower level of reserves—that, when taken individually, would not have been nearly as disruptive. In addition, we highlight how a lack of information transmission across repo segments and internal frictions within banks most likely exacerbated the spike. These findings are instructive in the context of repo market liquidity, demonstrating how the segmented structure of the market can contribute to its fragility.

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